

tornados.² The path of this disturbance being one-quarter of a mile southeastward, one-half mile eastward, three-quarters of a mile northwestward, one-quarter westward and one quarter northwestward. The storm traveled in all about 2 miles of city blocks [along a path recurving anticlockwise as described] the average direction was northwesterly. Figure 2 [not reproduced] shows the path of the storm and also the locations of the cooperative Weather Bureau station of Pasadena. After the whirlwind left the city limits it continued in a northwesterly direction and ascended the mountain ridge between Mount Lowe and Mount Markham. The writer noticed the effects of this storm when traversing the trail in that vicinity some weeks afterwards. One of the cooperative observers in these mountains reports that he heard the approach of the storm and the crashing of the pine trees as it plowed its way through the timber. Shortly after reaching the higher elevations the storm died out; the writer did not observe any damaging effects beyond the mountain ridge in which Mount Lowe and Mount Markham are located.

Description of the storm by eye-witnesses.—Fair weather prevails in southern California during more than three-quarters of the year, therefore any occurrence out of the ordinary is given unusually intelligent attention by the people generally. The case of the Pasadena storm was no exception to the rule. From a quantity of data collected the following two accounts are submitted. Prof. Ferdinand Ellerman of the staff of the Mount Wilson Solar Observatory writes Dr. W. J. Humphreys of the central office of the Weather Bureau as follows:

On January 26 [1918], we had a freak storm in Pasadena, where hail fell several inches deep in a very limited area, just as if it had been dumped, and a small-sized cyclone [?] did considerable damage. About 200 yards from my residence a pine tree over 2 feet through was uprooted, and many buildings unroofed, and barns and garages picked up and demolished. As near as I can learn the direction of rotation was clockwise, which, though contrary to cyclones in general, is not surprising to me, as considering the form of development it might take either direction. The sky on Mount Wilson was practically clear, and fog condensing from the slight rain the night before, increased in volume and banking up quite 3,000 feet above Mount Wilson's level, in a cumulus form. There was very little wind in Pasadena and a fair north wind on Mount Wilson. This occurred about 2 to 2:30. From the mountain we could not see the cyclone [i. e. tornadic storm] as the fog cut off the view.

From the notes of the cooperative observer at Pasadena, Mr. R. P. Hamlin, deputy city engineer, it has been possible to trace the path of the storm across the city.

Mr. Edwin R. Sorver, former cooperative observer at Pasadena writes:

The day was somewhat cloudy. About 2 p. m. it became very dark and a small tornado developed in the neighborhood of Fair Oaks Avenue and Union Street, traveling in a southeast direction for 2 blocks to Colorado Street and the Santa Fe tracks, tearing off roofing paper and blowing in a show window. It then followed Colorado Street east for 4 blocks, now and then becoming quite strong. A small amount of rain fell and hail fell. At Colorado Street and Euclid Avenue it blew in another show window and then turned directly at right angles going north and then northwest, which direction it kept until it dispersed. It now [after turning northwestward] began to grow very much in strength, uprooting large trees, taking the entire roof off an old school and striking the side of the Christian Church at Marengo and Walnut Streets. This church was built of large squares of concrete blocks. It demolished the entire side, throwing down several solid blocks together which probably weighed several tons. Its path, which was about 200 feet wide, could now be easily traced as it uprooted every tree, among them some very large peppers, and took off a number of roofs. Considerable damage was also caused by trees and debris, which were carried high up and then dropped (in one instance) through a house which was to one side of its path. The worst damage was done around the corner of Orange Grove Avenue and

Lincoln Streets, soon after which it dispersed. Here an entire orange grove of old trees was uprooted. This was on the place where the first house in Pasadena was built, which was still standing and was unhurt. It partly demolished a bungalow school, took the top off a church, completely wrecked a large garage, took the side out of a two-story house, and did considerable damage to other houses. The most remarkable part was that no one was hurt. The very black clouds did not follow the tornado, but moved off in the opposite direction. Snow and hail fell some 2 to 3 miles distant. There were, however, some white, low clouds which seemed to follow right over the tornado and which it connected with the ground many times. After it left Euclid Avenue and Colorado Street going northwest it appeared as a large and high whirling column of dust. Gradually, however, as it grew in strength it became a black funnel-shaped column resembling a water-spout. Once or twice it seemed to almost disappear, but then in not over five seconds would resume its old form. It did not seem to travel so very fast. At times there would be sucked through the center of it a fairly large column of what looked to be steam; this no doubt being intense condensation. The white clouds would then dip down into the column. It seemed to disperse very quickly as it moved into a section that was more open.

The above notes were made from Mr. Sorver's location in the Mather Building [No. 3, on fig. No. 2, not reproduced].

Deputy City Engineer R. P. Hamlin furnishes the photograph, figure 2, which shows the whirlwind just before it reached its maximum intensity. This illustration shows the counterclockwise wind movement as pictured by the inclination of the tree tops. Incidentally the location of the wind apparatus of the cooperative Weather Bureau station is given. Although the storm skirted this apparatus it is noted that the anemometer wind record sheet [not reproduced] shows no unusual velocities. The maximum wind, 18 miles per hour (the usual diurnal extreme), was reached at 2 p. m.

Several interesting incidents of the storm are related. A member of the Forest Service reports his aneroid barometer broken from the effects of the passage of the storm, the diaphragm being permanently collapsed. Another witness reports all four of the tires of his automobile, standing in the street, as having been deflated. It is also reported that just before the cottage [fig. 4 not reproduced] was destroyed the occupant started to close the kitchen door which had been blown open by the wind; before the door was reached the house was unroofed and the sides blown outward. All of these occurrences point strongly to tornadic action.

EVAPORATION FROM A CIRCULAR WATER SURFACE.¹

By N. THOMAS and A. FERGUSON.

[Reprinted from Science Abstracts, Sect. A, Jan. 31, 1918, § 71.]

The rate of evaporation from a circular water surface into a quiescent atmosphere was shown by Stefan to depend theoretically upon the radius of the surface, not upon its area. Experiments were made by the authors, both indoors and in the open air to test the dependence of evaporation upon the dimensions of the surface of evaporation, and upon the depths of the surface below the rims of the crystallizing dishes containing the water which varied in radius from 2 to 10 centimeters. If E is the rate of evaporation and a the radius of a dish, then assuming that $E = Ka^n$ where K depends on external conditions, it is found that in practice n is never so small as unity, the value required by Stefan's result, but varies from 1.5 when the dish is brimful, to about 2.0 when the depth of the surface is 3 centimeters or more below the brim of the dish. With the latter value, evaporation is proportional to the area of the evaporat-

² e. g., Henry, A. J. Cyclones, tornadoes, thunderstorms, squalls. MONTHLY WEATHER REVIEW, January, 1913, 46: 23-25.

¹ Phil. Mag., London, etc., October, 1917, 34: 308-321.

ing surface, and the method of expressing amount of evaporation by depth of water evaporated is justified. With the former value of n the depth of water evaporated varies inversely as the square root of the radius of the dish.—*R. C[orless]*.

REDETERMINATION OF HEAT OF VAPORIZATION OF WATER.²

By J. H. MATHEWS.

[Reprinted from Science Abstracts, Sect. A, Jan. 31, 1918, § 77.]

The author has redetermined the heat of vaporization of water, using the method devised by Richards and the author [Abstract 902 (1911)]. The apparatus employed has been improved more especially by the substitution of a vaporizer made of transparent quartz for those made of glass; and a better type of adiabatic calorimeter has been introduced. The water equivalent of the calorimetric system having been accurately determined, the author found that the heat required to vaporize 1 true gram of water into a vacuum at 100° is 539.0 calories._{15°}. Using another value of the water equivalent of the apparatus determined by an electrical method, the value for the heat of vaporization was found to be 540.0 calories._{15°}, a number that is in good agreement with that obtained by Smith, viz, 540.7 calories.—*A. F[indlay]*.

SUGGESTIONS AS TO THE CONDITIONS PRECEDENT TO THE OCCURRENCE OF SUMMER THUNDERSTORMS, WITH SPECIAL REFERENCE TO THAT OF JUNE 14, 1914.

By J. FAIRGRIEVE.

(Abstract of a paper presented to the Royal Meteorological Society, London, Apr. 17, 1918.

[Reprinted from Nature, London, May 2, 1918, 101: 179.]

The paper deals particularly with the thunderstorm of June 14, 1914. The meteorological phenomena accompanying the rainfall are put on record. The cloud distribution, the barometric pressure, the wind movements, and the temperature are specially dealt with. From an examination of the data it is evident that the clouds and the rainfields lie in parallel belts, and that the former appear some hours before the rain begins to fall. It is suggested that this belting of wind and rain may be due to rippling on a large scale, the rippling being brought about by the interaction of two currents of different temperatures. If the conditions are unstable, and especially if relief also induces disturbance, thunderstorms will develop along lines of rippling, and will drift with the wind. Thunderstorms have apparently three movements, a development along a belt, a sideways movement in the direction of the prevailing wind, i. e., to leeward, and a spread to windward. The first may be due to rippling; the second is a drift; the third may be explained if it is granted that a local ridge of high pressure develops along the axis of the thunderstorm. The thunderstorm then breaks up into two belts, of which the leeward soon dies out owing to the lack of a supply of rising air.

Topographic conditions from Allegheny Front eastward specially favor studies testing this theory.—*C. A. jr.*

² Jour. phys. chem., October, 1917, 21: 536-569.

EARTHQUAKE WEATHER.

The term "earthquake weather" is often encountered in California, but meteorological textbooks do not mention it. Those who use the term are unanimous in referring to a condition of hot and calm weather, without much cloud, but usually more or less haze. The condition is not greatly unlike that which usually precedes a summer afternoon thunderstorm in the Middle West. As the term "earthquake weather" has not yet become commonplace in scientific literature it would be interesting to learn what seismologists think about the matter.

The above paragraph appears in a recent issue of the Bulletin of the Seismological Society of America¹ in comment on the statement by Wendell P. Hoge, of the Mount Wilson Solar Observatory, that the 'quake of July 15, 1917, 11:05 a. m. at that observatory came with—

Weather partly cloudy, wind south, 3 mi./hr., relative humidity about 30 per cent, temperature 87°. General character of the weather for several days such as is often spoken of as "earthquake weather."

Readers of the MONTHLY WEATHER REVIEW may be interested in the following summary of what has been published on the subject so far in these pages.

South Australia.—Geo. H. Styles, of Port Caroline, South Australia, reported that during the month preceding the earthquake of May 10, 1897, there, the weather had been thick and squally with the wind all round the compass. On the day of the disturbance the wind force, which had been 6 to 8 for several days, fell to 2; the direction from the northeast and the weather fine with Ci.St. clouds.

At the same place in 1900 to March, 1901, 'quakes were accompanied by a sky usually covered with heavy Cu., "one or two of them bright, as though lighted by the moon, even during the darkest moonless nights." The cumuli never coalesced but if one overtook another they were mutually repelled, drifting away in feathery flakes and dissolving into clear sky before reaching the horizon. The sky was no longer the blue of the old days but of a milky, watery color.²

Jamaica, B.W.I.—Maxwell Hall reports that there are not enough earthquakes in Jamaica to permit a complete investigation of a possible relationship between them and weather phenomena. He states that the cause of the oppressive weather noticed before an earthquake is the stopping or diminution of the wind. The barometer is also affected and St. tends to form.³

Japan.—Omori found that maximum earthquake activity generally coincides with times of high atmospheric pressures; but that just the reverse is true at some stations where it usually is accompanied by low barometric readings. The apparent contradiction has been explained away by Dr. K. Honda.⁴

California.—The California earthquake of April 18, 1906, called forth an interesting paper from San Francisco students,⁵ in which the atmospheric conditions are described and commented on. That morning—the weather map for the day indicates the conditions throughout the United States just a few minutes previous to the 'quake—was clear and pleasant over the greater portion of the Pacific coast. A high was moving steadily and somewhat slowly eastward across Idaho, and the pressure distribution was of a type that prevails when certain earthquakes occur in California. While experience in

¹ See Andrew H. Palmer: California earthquakes during 1917. Bull., Seism. soc. America, Stanford University, California, March, 1918, 8: 10.

² Styles, Geo. H. "Earthquakes, clouds, and gales at Port Caroline, So. Austr." MONTHLY WEATHER REVIEW, January, 1902, 30: 10.

³ Hall, Maxwell. The Jamaica weather service. MONTHLY WEATHER REVIEW, July, 1898, 26: 304.

⁴ See Tamura's abstract of Honda's paper, "Daily periodic changes in the level of artesian wells in Japan. MONTHLY WEATHER REVIEW, July, 1905, 33: 303-304.

⁵ Richter & McAdie. Phenomena connected with the San Francisco earthquake. MONTHLY WEATHER REVIEW, November, 1907, 35: 505.